

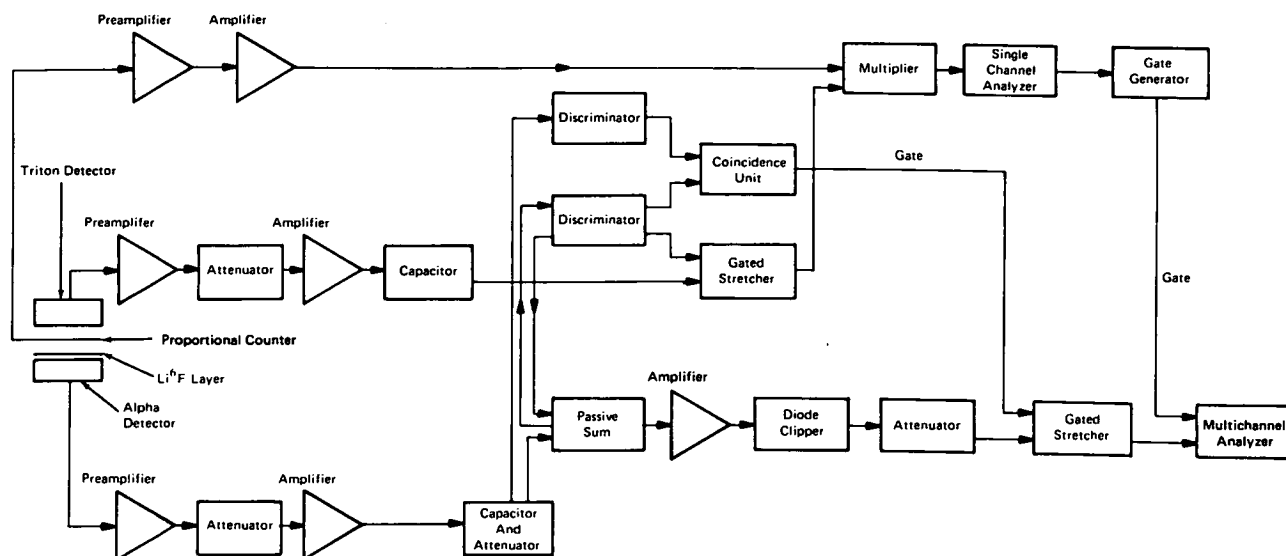
NASA TECH BRIEF

Marshall Space Flight Center



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Fast-Neutron Spectrometer Developments



Block Diagram of Li^6 Spectrometer and Particle Identification System

Neutron spectrometers have been used for monitoring and studying nuclear reactors. Tests have shown that, when high-energy neutrons are studied, reactions in the silicon detectors interfere with the measurements.

This problem may be overcome to a significant extent by a Li^6 sandwich-type neutron spectrometer equipped with a proportional counter for particle identification. The unique feature of this system is its ability to minimize the pile-up of gamma-ray and particle pulses by using current-sensitive preamplifiers.

The figure shows a block diagram of the spectrometer and particle identification system. The spectrometer utilizes two 900 ohm-cm silicon surface barrier detectors, one an uncoated triton detector and the other an alpha detector that is evaporation coated with $500 \mu\text{g}/\text{cm}^2$ of Li^6F . The spectrometer shield is made of 8% gadolinium oxide and 80% boron (enriched to 92%

B^{10} to enhance absorption and allow a smaller shield thickness).

Background gamma radiation is rejected by combining the characteristics of the detector reaction [$\text{Li}^6(n,t)\text{H}^4$] with the use of nanosecond electronics. The $\text{Li}^6(n,t)\text{H}^4$ reaction has a high Q (4.785 MeV) and yields coincidental alpha and triton particles. The current-sensitive preamplifiers form signal pulses of approximately 15 nanoseconds. The probability of including random gamma-ray events is reduced through the use of 15-nanosecond wide electronic gates that are opened only by coincident alpha particle and triton events. In the absence of background radiation, peak height analysis of thermal neutron events give a peak that is approximately 300 keV full-width at half-maximum and remains less than 500 keV until the gamma-ray field strength reaches around 20,000 R/hr.

(continued overleaf)

As are most semiconductor detectors, this one is susceptible to radiation damage. The primary limitation is the total fast neutron dose which the detector can tolerate. However, a considerable dosage is required before resolution begins to fall off. This is because the effect of preamplifier noise on resolution is much greater than the intrinsic resolution of the unirradiated detectors. One of the detectors is able to withstand a total fission neutron dose of 4×10^{12} neutrons per cm^2 and the other 10^{13} before failure.

The electronics in this system have been miniaturized. A blocking circuit may be added to eliminate the pile-up of good coincidence events in the slow (microsecond) portion of the circuitry, and a dead time meter could be used at high flux levels. The electronic circuitry, without the multichannel analyzer, occupies a volume of less than 820 cm^3 and requires only 7 watts from a 28-volt direct current source.

Note:

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Technology Utilization Officer
Marshall Space Flight Center
Code A&PS-TU
Marshall Space Flight Center, Alabama 35812
Reference: B73-10116

Patent status:

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Patent Counsel
Marshall Space Flight Center
Code A&PS-PAT
Marshall Space Flight Center, Alabama 35812

Source: R. B. Moler, W. E. Zagotta, and
S. I. Baker of
IIT Research Institute
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